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ABSTRACT

Choosing a machine for the new microcomputing program at Drexel University is described. It was necessary to give students access to computing capabilities that were versatile and powerful enough to assist them in the full range of their coursework. The university made the decision to have students bear part of the expense of the new curricular demands through purchase of their own computers. The selection committee had to identify criteria for both hardware and software based on an understanding of how students would be using the microcomputer in their courses. The following key issues that might also be relevant to other schools are discussed: the needs of each group affected by the program, the power and versatility of the computer, the question of whether the machine was in line with the newest directions in microcomputer technology, the ease with which a machine can be operated, graphics capabilities, sound generation capabilities, the growth capacity of the microcomputer, the cost to the student and to the university, and the vendor. Essential requirements for hardware and software are outlined, along with desired capabilities. (SW)

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THE MICROCOMPUTING PROGRAM AT DREXEL UNIVERSITY

CHOOSING THE MACHINE

THE SELECTION DECISION AT DREXEL UNIVERSITY

In the Fall of 1982, Drexel University decided to introduce a dramatic, new educational program for the 1983-84 academic year. The new program, which is presently underway, requires every freshman to have access to a personal computer for use in courses ranging from the sciences to the humanities.

The goal of this comprehensive program is to provide Drexel students with the resources and training necessary to meet the challenges of the future — a future in which effective use of computers will be essential in virtually every field.

While Drexel certainly does not intend to make all its graduates computer scientists, it does seek to create an environment in which students learn about computers and become comfortable working with them as part of their regular coursework. The kind and degree of computer proficiency required will depend upon the student's academic concentration. Some will need to gain competency in one or more programming languages and environments; others will need to master a variety of application packages. In all cases, however, the emphasis at Drexel will be on using the computer as a powerful tool for exploring concepts and doing work.

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THE CHALLENGE OF THE PROGRAM

The challenge of this program was to select a machine which (1) would be compatible with the unique nature of Drexel University and (2) would be powerful and versatile enough to equip Drexel students with the skills necessary for work in the years ahead.

Drexel University is located in the University City area of Philadelphia, only a few minutes by public transportation from the downtown area. Drexel was originally developed as a technological institute. Although it has since attained university status and now offers an extensive liberal arts curriculum, it still maintains a strong technological and applied orientation.

Approximately one-half of all Drexel students commute to the campus. Of the approximately 13,000 students enrolled, about 7,500 are regular daytime undergraduate students. The rest are divided among the evening college and the graduate programs. The University operates year round on a four-quarter system.

Many of the students hold part-time jobs while they are attending classes full time, and almost all (95%) participate in the University's co-op program. Through this program, which lengthens the undergraduate course of study to five years, students spend six months of each of their three middle undergraduate years working in a job related to their major area of study. Co-op places approximately 1/3 of all undergraduates every quarter in over 1,300 businesses and corporations in the Delaware Valley and throughout the country.

As with any technologically oriented university, Drexel has already made sizable investments in on-campus computing facilities. This investment increased substantially during the past four years as a number of multi-user systems were installed throughout the campus. (These systems are still heavily used for both instructional and research computing, with emphasis on scientific computing and on mainframe-based statistical and graphics applications.)

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The above features of the University supplied the primary context for all decisions relating to the microcomputer selection. Given the University's diverse curriculum, the microcomputer chosen had to be flexible and sophisticated enough for students to use in even the most technically advanced courses. Given that half of Drexel's students don't live on campus, a stand-alone unit was preferable to a system of terminals connected to a central mainframe computer. And given the almost universal student participation in the co-op program, the machine had to be transportable so that students could take it with them on their job placements, if they chose, and thereby increase their value to their employers.

Indeed, the short-term and long-term needs of Drexel students became an additional context for decision-making. It was necessary to give students access to computing capabilities which were versatile and powerful enough to assist them in the full range of their present coursework and in their future careers.

Drexel, like many other universities, had foreseen that, if changes were not made, students would have to stand in line for considerable periods of time to gain access to limited interactive computing facilities. One solution was to pour huge sums of money into expansion of the University's computer resources. A more economic solution, both for the University and for students, was to have the students bear part of the expense of the new curricular demands through purchase of their own computers. This, then, was the decision which Drexel eventually made.

There were several additional benefits to this decision. The University could reduce its commitment to technologies that would undoubtedly become obsolete. Students would also have a greater incentive to take care of the computing equipment they used if it belonged to them. Finally, by gaining direct access to their own microcomputers, students would be able to experiment on their own without the frustration of long waits at the computer center.

Moreover, the microcomputer would help students by helping their professors become better teachers. Instructors would now have at their disposal a new educational tool with which they could present concepts difficult to explain using other means. The microcomputer would allow them to re-examine their current teaching methods and consider ways in which their teaching might be improved.

OVERVIEW OF THE SELECTION PROCESS

The following pages describe the process by which Drexel University arrived at its selection of a specific microcomputer. It is not an attempt to justify the choice that was made, but rather to share the experience with other universities currently undergoing or contemplating a similar process. We don't contend that our procedures are flawless or that they were performed according to the best set of criteria. They merely represent our best effort at the time.

The initial decision to introduce personal computers at Drexel was made by academic administrators at the very top levels of the university. In October of 1982, the President announced his decision to require all students to have access to a microcomputer for the 1983-84 academic year. Immediately, a microcomputer Selection Committee, composed of University faculty, was created to define the instructional computing needs of the institution and establish the physical requirements of a computer which could meet these needs. The committee was also asked to identify manufacturers who could deliver a suitable product.

After a lengthy and complex review process, the faculty Selection Committee arrived at a set of software and hardware requirements and a pool of "recommended" manufacturers whose products met the established criteria. The Vice President of Academic Affairs and his staff then met with representatives of these manufacturers. The final negotiations were carried on by the Vice President for Academic Affairs and the University's chief financial officer.

The rest of this document describes the work of the Selection Committee in developing formal criteria for selecting and evaluating a manufacturer.

THE SELECTION COMMITTEE: ITS MAKE-UP

Representatives of five of the six Drexel Colleges (Science, Humanities and Social Sciences, Business and Administration, Engineering, and Information Sciences) were appointed to the committee along with the Academic Services Manager of the Computer Center. This group represented a variety of seniority levels within the University. Moreover, each member represented not only his or her college and level of experience but also a unique point of view based on individual research and teaching experience.

The decision to put the selection process in the hands of a broad-based faculty committee not only helped assure that the decision was fair to the faculty at large, but also helped secure the degree of faculty support which followed.

THE TASK OF THE COMMITTEE

The task of the faculty selection committee was to determine the criteria for selecting a machine for use across the Drexel curriculum. The information network which the selection committee set in motion and the trust which these academic leaders were able to inspire were crucial to the success of the program. This was true despite some necessary constraints (such as nondisclosure agreements) which limited the free flow of discourse traditional in an academic community.

By identifying actual need and use, by writing specifications, and then by identifying specific equipment compatible with those needs, the committee was able to see the microcomputer program within a broad perspective and thus subordinate individual biases for or against a particular piece of hardware to larger goals.

The selection committee began by pooling hardware and software information based on the individual experiences of its members. They then proceeded systematically to answer the questions which emerged as they tried to match this information with the acknowledged needs of the University. The eventual recommendations of the committee were based on at least five different kinds of information:

(1) **Prior experience with computing in general.** This included experiences on large mainframes and minicomputers as well as on micros.

(2) **Information gained from specific vendors.** Vendors were asked to bring in equipment which they felt might be appropriate, to answer questions, to provide demonstrations, and to examine with the committee the pros and cons of their equipment in light of the formal criteria established by the committee.

(3) **Systematic review of published information.** Popular literature and a variety of periodicals were useful sources of information that helped enlarge the perspective of the committee.

(4) **Input from colleagues.** Impressions, biases, and prejudices for and against specific machines abounded within the University environment. A variety of "unscientific" factors had to be taken into account in order to identify those machines that could meet student needs and gain faculty approval.

(5) **Intangible factors.** Certain factors were difficult to identify but impossible to eliminate. These included such intangibles as enthusiasm and intuition.

CONSIDERATIONS IN THE DECISION

The committee had to identify criteria for both hardware and software. But to do this, the members needed a more substantive understanding of how freshmen would be using the microcomputer in their courses. Some of the applications were clearly apparent; some were less so. The following paragraphs reflect the key issues which emerged at Drexel and which might be relevant to other schools considering a similar decision.

THE CRITICAL AUDIENCE. The University is a pluralist community. It seeks to meet the sometimes disparate needs of faculty, students, administrators, and other concerned parties. With so many interests represented, the committee first had to evaluate the needs of each group and determine the trade-offs which could be made.

With the introduction of the microcomputer, the interests of parents had to be considered as well. They, for the most part, would be financing their children's purchase of a machine. From the outset, parents asked probing questions of the administration. They wanted to know how the computer would be used throughout the curriculum and what criteria were being applied in the selection process. When they received reasonable answers to these questions, their concern diminished. The Drexel experience has demonstrated that parents will not oppose the outlay of an extra thousand dollars if they are convinced that this money serves a valid educational purpose.

Questions from the faculty reflected a different orientation. Faculty wanted a machine which would further their research capabilities as well as enhance their teaching. In making its selection, the University had to respect faculty needs. Yet care had to be taken not to gratuitously increase student cost for faculty benefit. In other words, while it was important to consider how faculty research could tie into undergraduate instruction, research needs could not be allowed to elevate the cost of the machine to such a degree that students would pay for faculty research.

COMPUTER POWER. In one area, at least, there was unanimous agreement. The University should not purchase a toy or video-game type of machine. Neither should it fall into the trap of simply requiring the student to have an expensive typewriter; that is, a machine geared primarily to word processing. (Defining the category into which a machine falls, however, is actually quite difficult. For example, any machine with limited capability may have exceptional potential for expandability.) The trade-off between cost and computational power became the critical issue. The committee ultimately took the position that there could be no savings to students if they would have to purchase an additional, more powerful machine during their academic career in order to replace one with limited capacity. Clearly, the machine chosen would have to be at least powerful or expandable enough to serve them during their full course of study at Drexel.

DEGREE OF INNOVATION. The problem posed by a rapidly changing technology was another matter of major concern to the committee. If the machine selected were not in line with the newest directions in microcomputer technology, it threatened to become obsolete in the course of a student's five-year undergraduate education. At the same time, newer technology has not yet undergone the test of time. New technology is also liable to produce greater anxiety in the user than the more established and familiar technology.

USER INTERFACE. The terms "user friendly" and "human interface" have both become common jargon. They refer to the ease with which a machine can be operated — a feature which is of special value to the novice. Improvements in "human interface" have been dramatic in recent years, and it is now becoming more and more possible to interact with a computer without having to learn a separate vocabulary or program in a traditional, computationally oriented language.

Because microcomputers were to be introduced *en masse* within the University, the training necessary had to be relatively simple. Students and faculty could not be distracted from primary education objectives in order to learn intricate computer methodologies or esoteric languages. The microcomputer would serve as a tool in learning the subject matter of a particular field, and not as an end in itself. It followed, therefore, that a "friendly" user interface became a high priority in the selection process. Fortunately, manufacturers' options in this area were fairly extensive. There now exist a variety of methods for communicating with the machine without learning a series of mystical commands. These include such options as the operation of a menu, the use of a typewriter keyboard, the movement of a mouse or light wand, or the mere touching of the screen.

Initially, some faculty perceived the "user-friendly" options as gimmickry, since these features tend to support software systems which are not the traditional computer-based functions. However, there is no essential conflict between an easy-to-use interface and sophisticated computer functions. The committee quickly undertook to convince faculty that they would lose nothing by adopting a "user-friendly" machine.

GRAPHICS. Graphics capabilities also became a priority in the selection process. Many people perceive computers as dull machines which merely calculate, combine, and correlate. But this is to ignore totally the educational and creative potential of computers. Microcomputers today have a marvelous capacity for presenting information visually through graphs, charts, and animated simulations. Graphics programs are now available which allow for drawing and sketching, for the layout of architectural designs, and for the representation of two- and three-dimensional objects. Graphics capabilities are, therefore, important aids in teaching concepts which possess a visual dimension. At Drexel, this component figures prominently in courses ranging from engineering to sociology and fashion design.

Moreover, the introduction of microcomputer graphics encourages faculty members to "re-see" the ways in which they present information in their disciplines. With the microcomputer, an instructor must consciously select from among a variety of visual options in presenting a theory or set of facts. Sometimes the use of graphics can illuminate an obscure idea or bring to life a tired concept.

HARDWARE

ESSENTIAL REQUIREMENTS

- Minimum of 48K RAM
- One disk drive (160K storage minimum)
- 80 character display on monitor
- Bit-map graphics (192x280 pixels)
- RS-232 interface
- High reliability and durability
- All anticipated hardware from one vendor

DESIRED LONG-TERM CAPABILITIES

- Additional RAM
- Second disk drive
- Modem/Accoustical coupler
- Interface for data acquisition/control
- Color graphics
- Sound generator

SOFTWARE

MANDATORY REQUIREMENTS

- Word processing
- Spreadsheet
- FORTRAN
- BASIC
- Pascal
- Graphics
- Application packages
- Terminal emulation
- Database Management

DESIRED CAPABILITIES

- LISP
- LOGO
- APL
- FORTH
- COBOL
- Authoring languages

In evaluating graphics capabilities, however, it is important to know what to look for. Traditional graphics packages on microcomputers are devoted to business graphics: they compute pie charts, bar charts, and other representations of data. These are necessary capabilities for many applications, but they are limited. In other disciplines, such as the natural sciences or engineering, it is necessary to plot data in a variety of different coordinate systems and to examine visually the degree to which these data fit some mathematical model. Finally, in disciplines like engineering, it is necessary to program both static and dynamic images. This requires high resolution graphics not just the display of alphanumeric characters.

SOUND. Sound generation also increases the usefulness of the computer across a diverse curriculum. Both the music department and the electrical engineering department at Drexel are presently using microcomputer-generated sound, and additional uses are anticipated in other disciplines. Voice synthesis, which is now being developed for a number of computers, will soon be available to enhance the "user friendly" interface of a machine.

GROWTH CAPACITY. The selection committee was also interested in establishing the growth capacity necessary for the Drexel computer.

To keep the initial price of the machine as low as possible, it was agreed that only the essential system specifications be required. But this primary system would be of short-term value since it could only be used for the more basic applications. Once these were mastered, the machine itself would have to be able to grow with the student. The ability to upgrade memory as well as to add peripherals (such as additional disk drives) would be necessary. Students in certain curricula might also need to add plotters, digitizing pads, tone generation hardware, color graphics capabilities, and analog-to-digital convertors. A machine's ability to accommodate these devices was therefore crucial if it was to serve students effectively as they progressed through the curriculum.

Part of a computer's growth capacity is its ability to tie into other computer systems. This is possible if the machine can emulate an intelligent terminal or workstation, connected to other computers either through a modem and phone lines or through a local-area network. This coupling of microcomputers with various communication technologies would give students access to computing resources which are far more powerful than their stand-alone units. If the student and faculty machines could link up with larger computers on campus, then a network could be created in which students and faculty could communicate with each other, collect assignments off a central facility, leave messages, and perform other useful operations. A network of this kind will inevitably exist at most universities some day. But until many of the costs and logistical difficulties are overcome, the stand-alone unit can still be an operative and useful piece of equipment.

Finally, growth had to be considered in relation to software. It is essential to the educational experience that a student build and/or acquire a library of special-purpose software tailored to his or her own specific needs. The Drexel program requires all students to purchase some basic core of generic software, such as word processing, graphics, and spreadsheet. Additional laboratory and departmental software will be required as students take more advanced coursework in their fields. Thus, upon graduation, they will be able to take not just a piece of hardware but a variety of specific tools with them into the marketplace, graduate school, or wherever their careers may lead them.

COST. Two types of cost must be considered: cost to the student and cost to the University.

The students, of course, will not bear the full cost of introducing the microcomputers into the curriculum. The University must assume the financial burden of setting up laboratories and common print facilities. (Drexel students are not required to purchase their own printers.) The University also pays for the additional staff hired to provide support services such as repairs, security, and consultation on computer operation.

It must also provide resources in the form of technical and design assistance to faculty. Finally, the University must be able, where necessary, to help students finance their own computers. (At Drexel, a bond issue was undertaken in order to make a bulk purchase of machines. This has also helped students finance their purchases at lower-than-market rates over the course of their five-year undergraduate career.)

While it is unreasonable to ask students to spend $5,000 for their first computer, it is similarly unfair to require them to buy a $300 machine that they would outgrow within the first year. One way to achieve an acceptable price tag without sacrificing desirable specifications is through mass purchase by the University.

Beyond the initial purchase of equipment, follow-on costs for items such as diskettes, paper and other supplies, maintenance, software, and additional peripherals must also be considered. Since security risks come with bringing so many machines into a specific area, insurance costs must also be added in. Thus the initial cost of financing a $1,000 machine may only amount to $250 to $270 per year over a five-year period, but additional costs can boost the figure to $400 or $500 per year. These costs must be considered in helping students prepare financial aid documents and advising them in financial planning for their academic careers.

THE SOURCE OF THE COMPUTER. The costs and capabilities of a machine are certainly of primary importance in making a mass purchase, but the company with which the University decides to do business is also significant. The University must select a company which is likely to be in business and offering support services throughout the life of the selected product. (Recent history suggests that many, if not most, of the current vendors will not be around five years from now.)

Another issue to consider is the image of the company selected. University-wide adoption of a single machine means that the product will become closely identified with the University. Members of the Selection Committee wanted Drexel to identify itself with a technological leader and innovator. They also sought a company with a reputation for producing reliable and durable equipment and with a commitment to the education market.

THE SOLUTION AT DREXEL UNIVERSITY

After taking the above factors into account, the Selection Committee and the University administration arrived at a final decision. Beginning Winter term of 1983-84, all freshmen would be required to purchase a new product from the Apple Computer Company: the Apple Macintosh. The Macintosh met, and sometimes exceeded, the criteria established by the committee. It could be used across the curriculum, beginning with the freshman year. Incoming freshmen in future years would also be requested to buy this computer, or later versions of it.

CONCLUSION

The selection of a single microcomputer for use by all students is a major decision. It will have an impact on the reputation of the institution and will undoubtedly affect the curriculum itself. Therefore, it is imperative that this decision reflect the academic goals and identity of the institution.

The decision to require microcomputers at Drexel in the early 1980's has been seen by many as a trend-setting decision. In the year following Drexel's decision, representatives of over 70 colleges and universities contacted or visited Drexel University to seek additional information on how and why Drexel made this decision. Drexel is pleased to be in a position to assist other institutions as they equip themselves to enter the information-based society in which we will live for the next decades.

In this document, we have sought to identify those issues which contributed to the selection of a microcomputer which was right for Drexel. Perhaps the presentation of these issues will provide a starting point for other schools in making selections which are right for them.

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